CLAIMS

What is claimed is:

1. A method of repairing a circuit, comprising the steps of:
   a) depositing a thin film composition comprising nanoparticles of at least one electrically functional material on or over a region of said circuit to be repaired such that said thin film composition contacts first and second elements of said circuit; and
   b) irradiating at least a portion of the thin film composition with a wavelength of light for a length of time and at an intensity sufficient to convert said nanoparticles to an electronically functional film, fuse said nanoparticles or bind said nanoparticles to each other.

2. The method of Claim 1, wherein said length of time is sufficient to convert said thin film composition into an electronically functional thin film.

3. The method of Claim 1, wherein a source of said light comprises a laser.

4. The method of Claim 1, wherein said nanoparticles comprise metal nanoparticles.

5. The method of Claim 1, wherein said composition further comprises a sensitizer configured to selectively absorb said wavelength of said light.

6. The method of Claim 5, wherein said light has a bandwidth of 40 nm or less.

7. The method of Claim 1, wherein said light consists essentially of infrared light with an emission maximum of from about 800 to about 850 nm.

8. The method of Claim 1, wherein said light has properties and said wavelength has a penetration depth such that illumination intensity at an interface between said thin film composition and said first and second elements of said circuit is sufficiently high to convert said nanoparticles near the interface to an electronically functional film.

9. The method of Claim 8, wherein said intensity at the interface is > 25% of an incident intensity.

10. The method of Claim 1, wherein at least one circuit component absorbs said wavelength of light at an efficiency sufficiently low to prevent detrimental effects to said component or an adjacent component.

11. The method of Claim 1, wherein said nanoparticles comprise a precursor to a semiconducting film.

12. The method of Claim 1, wherein said nanoparticles comprise a precursor to a dielectric film.

13. The method of Claim 1, further comprising the step of developing said irradiated thin film to remove non-irradiated portions or portions adjacent to the irradiated portion of the composition.

14. The method of Claim 1, further comprising, prior to said depositing step, the step of exposing the first and second circuit elements.

15. The method of Claim 14, wherein said exposing step comprises laser ablation.

16. The method of Claim 14, further comprising, after said exposing step and prior to said depositing step, the step of preparing a surface of said first and second circuit elements for said depositing.

17. The method of Claim 16, wherein said preparing step comprises cleaning said surface of said first and second circuit elements.

18. The method of Claim 1, further comprising covering a repair area formed by said irradiated thin film composition with a coating, passivation or capping material.

19. The method of Claim 18, wherein said covering step comprises dispensing a liquid precursor onto said repair area, said liquid precursor forming said coating, passivation or capping material upon further treatment or processing.

20. The method of Claim 19, wherein said covering step further comprises laser curing said liquid precursor.

21. The method of Claim 19, wherein said liquid precursor comprises a polyimide, spin on glass, polysesquiloxane, or PDMS.

22. The method of Claim 21, wherein said liquid precursor comprises said polyimide and a thermal sensitizer.

23. The method of Claim 13, wherein said developing step comprises locally rinsing said irradiated thin film with a developer.

24. The method of Claim 23, wherein said developer comprises an organic solvent.

25. The method of Claim 24, wherein said developer comprises a member selected from the group consisting of toluene, butyl ether, xylene, 3-octanol and terpinol.

26. The method of Claim 13, where the developing step comprises exposing the irradiated and non-irradiated portions of the composition to a solvent which dissolves portions of the composition in which said nanoparticles are not fused, bound to each other or the substrate, or converted to an electronically functional film.

27. The method of Claim 13, where the developing step comprises exposing the irradiated and non irradiated portions of the composition to a jet of particles.

28. The method of Claim 27, wherein the particles rapidly convert into a gas, enhancing the removal of material from the non-irradiated portions of the composition.

29. The method of Claim 27, wherein said jet of particles comprises dry ice (solid carbon dioxide).

30. The method of Claim 1, further comprising flowing a gas towards or away from the irradiated portion sufficiently to remove one or more by-products of the irradiating step.

31. The method of Claim 1, further comprising, prior to said irradiating step, the steps of placing said substrate into a chamber, evacuating said chamber, and passing an inert and/or reducing gas into said chamber.

32. The method of Claim 1, further comprising heating said irradiated portion of said thin film composition.

33. The method of Claim 32, wherein said heating comprises flowing heated gas over said irradiated portion of said thin film composition.

34. The method of Claim 32, further comprising the step of post-thermal processing the irradiated portion of said thin film composition.

35. The method of Claim 34, wherein said post thermal processing comprises exposing said irradiated portion of said thin film composition to radiation.

36. The method of Claim 35, wherein said post thermal processing comprises locally exposing said irradiated portion of said thin film composition to radiation.

37. The method of Claim 35, wherein said radiation is provided by a laser.

38. The method of Claim 35, wherein said radiation has a wavelength of less than 500 nanometers.

39. The method of Claim 35, wherein said post thermal processing is conducted sufficiently to improve a conductivity of the irradiated portion of said thin film composition.

40. The method of Claim 35, wherein said post thermal processing is conducted sufficiently to improve adhesion of the irradiated portion of said thin film composition to an underlying or adjacent layer.

41. The method of Claim 35, wherein said post thermal processing is conducted sufficiently to relax a stress and/or improve a morphology or profile of said irradiated portion of said thin film composition.

42. The method of Claim 1, further comprising examining or testing said circuit to find and/or locate said region to be repaired.

43. The method of Claim 42, further comprising fabricating a circuit or circuit element prior to said examining or testing step.

44. The method of Claim 43, wherein each of said fabricating, said examining or testing, said depositing and said irradiating steps are performed by a single tool.

45. A method of repairing a circuit, comprising the steps of:

a) depositing a thin film composition comprising a solution precursor to a semiconducting material on or over a region of said circuit to be repaired such that said thin film composition contacts at least one element of said circuit; and

b) irradiating at least a portion of the thin film composition with a wavelength of light for a length of time and at an intensity sufficient to convert said solution precursor to an electronically functional film, convert said solution precursor to a corresponding oxide and/or nitride, or make said solution precursor insoluble in a subsequent developing step.

46. The method of Claim 45, wherein the solution precursor includes a silane.

47. The method of Claim 45, wherein the method repairs a circuit by adding a new semiconducting element to the circuit.

48. The method of Claim 45, further comprising the step of oxidizing or nitriding the deposited thin film composition sufficiently to produce an insulating feature.

49. A composition, comprising:
   a) nanoparticles of an electronically functional material, said nanoparticles having an light absorption maximum at one or more first wavelengths; and
   b) a sensitizer having a light absorption maximum at a second wavelength different from each of said first wavelengths.

50. The composition of Claim 49, wherein said second wavelength differs from each of said first wavelengths by at least 20 nm.

51. The composition of Claim 49, further comprising a first compound that enhances adhesion or electrical contact to an underlying or adjacent component.

52. The composition of Claim 51, wherein said first compound comprises a member selected from the group consisting of Au, Pd, Cr, Ti, Ni, P, B, As, Si and Ge.

53. The composition of Claim 49, further comprising a second compound that enhances the morphology of the thin film.

54. The composition of Claim 53, wherein said second compound comprises a member selected from the group consisting of Pd, Co, and Si.

55. An ink for making an electrically functional thin film, comprising:
   a) the composition of Claim 49; and
   b) a solvent in which said composition is soluble.

56. A structure, comprising:

a) one or more circuit elements on a substrate, said one or more circuit elements having first and second locations with an anomalous electrical resistance or an electrical disconnect therein or therebetween;

b) a cured electrically functional material comprising light-irradiated nanoparticles, said cured electrically functional material (i) being in electrical contact with said first and second locations adjacent to said anomalous electrical resistance or said electrical disconnect, and (ii) forming a continuous, electrically conductive path between said first and second locations.

57. The structure of Claim 56, wherein said circuit element comprises a wire of electrically conductive material.

58. The structure of Claim 56, wherein said cured electrically functional material comprises a line having a width of from 100 nm to 100 μm.

59. The structure of Claim 56, wherein said cured electrically functional material comprises a substantially horizontal portion and first and second substantially vertical portions, said first and second substantially vertical portions respectively being in electrical contact with said first and second locations.

60. A structure, comprising:

a) one or more circuit elements on a substrate, said one or more circuit elements having an anomalous electrical resistance, conductance or transconductance or an electrical disconnect therein or therebetween;

b) a cured electrically functional material comprising light-irradiated nanoparticles and/or liquid phase semiconducting materials, said cured electrically functional materials (i) being in electrical contact with first and second locations on said one or more circuit elements adjacent to opposed ends of said anomalous electrical

resistance, conductance, transconductance or said electrical disconnect, and (ii) forming an electrically conductive, semiconducting or nonconducting path between said first and second locations.

61. The structure of Claim 60, wherein said cured electrically functional material comprises a resistor.

62. The structure of Claim 60, wherein said cured electrically functional material comprises a capacitor.

63. The structure of Claim 60, wherein said cured electrically functional material comprises a diode.

64. The structure of Claim 60, wherein said cured electrically functional material comprises a transistor.

65. An apparatus for repairing an electrical circuit, comprising:

a) a deposition apparatus configured to deposit a thin film of an electrically functional material from a liquid phase in a predetermined pattern on a substrate comprising said electrical circuit;

b) a source of light configured to irradiate said thin film; and

c) a platform or table configured to support and secure said substrate such that said thin film may be deposited on first and second exposed portions of said electrical circuit and irradiated with said light.

66. The apparatus of claim 65, further comprising a housing configured to contain both said deposition apparatus and said source of light.

67. The apparatus of claim 65, further comprising:

   a) a container configured to hold said electrically functional material in said liquid phase; and

   b) a tube or conduit configured to transport said electrically functional material in said liquid phase from said container to said deposition apparatus.

68. The apparatus of claim 65, wherein said deposition apparatus comprises a member of the group consisting of a dropper, a needle, a microsyringe and an inkjet head.

69. The apparatus of Claim 65, wherein said source of light comprises a laser diode.

70. The apparatus of Claim 65, further comprising a development sub-apparatus comprising a fluid delivery system configured to deliver developing solution to the deposited and irradiated thin film.

71. The apparatus of Claim 70, wherein said fluid delivery system comprises a vessel for holding the developing solution.

72. The apparatus of Claim 70, further comprising a fluid removal apparatus for removing the developing fluid from the substrate.

73. The apparatus of Claim 70, wherein said fluid delivery system further comprises a developing solution spray jet.

74. The apparatus of Claim 65, further comprising a developing sub-apparatus including a particle jet.

75. The apparatus of Claim 74, wherein said particle jet comprises a dry ice particle jet.

76. The apparatus of Claim 70, wherein said developing sub-apparatus further comprises a gas outlet configured to provide a flow of air onto or over said deposited and irradiated thin film.

77. The apparatus of Claim 65, further comprising an integrated circuit testing apparatus.

78. The apparatus of Claim 77, further comprising an integrated circuit fabrication apparatus.

79. The method of Claim 1, further comprising the step of patterning a low surface energy thin film material.

80. The method Claim 79, wherein the patterning step comprises exposing a photopatternable or thermally patternable low surface energy material to laser irradiation.

81. The method of Claim 79, wherein said patterning step comprises:

   a) dispensing a liquid low surface energy thin film precursor onto said region of said circuit to be repaired;

   b) exposing the liquid low surface energy thin film precursor to laser radiation such that the low surface energy thin film material is fixed to a surface of said region other than an area where the nanoparticle thin film composition is to be deposited; and

   c) developing the liquid low surface energy thin film precursor and the high surface energy thin film material to remove the unexposed liquid high surface energy thin film precursor.